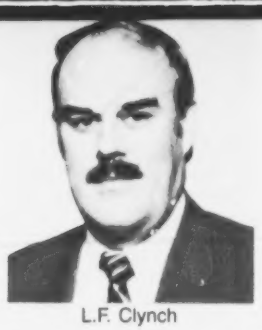

L.F. Clynch

H.L. Crawford Jr.

R.C. Darwin

Here's How Seven Major Liquids Pipeline Companies Plan To Modernize/Replace Pump Stations

	1984	1985-87
Number of stations to be modernized	61	68
Number of stations to be replaced	1	2
Total expenditures for modernization/replacement	$17.5 million	N/A

amount of power being used at any one time, and use curtailable power, which some electric utilities will offer at a discount.

Clynch: Electric power costs are our largest single expense. To overcome this problem, we are using "CDR" drag reducer; we achieve power factor correction with capacitors, especially in rural areas; and we continuously overhaul pumps to keep them up to specifications. We've also had to use reduced voltage starters in areas where full voltage starting cannot be allowed.

Crawford: We are very conscious of energy costs — it is our biggest operational expense.

Dennard: Cost of power is the greatest influence in considering replacements or modernization.

Zimmerhanzel: Electrical power costs are a major consideration. We have a few engine-driven stations... less than 10%. The remainder are electric motor-driven.

Darwin: Energy costs are a very large element in the overall cost picture, not including oil losses. Over 90% of our mainline stations are electric. The others have natural gas fueled internal combustion engines as prime movers.

PGJ: *What is the trend in pump station prime movers?*

Dennard: On our products pipelines, variable speed a.c. motors may be an answer to variations in pumping requirements. On crude pipelines, the trend is operational — make sure impellers are the right size; have enough equipment to move the crude efficiently; and operate whenever possible to take advantage of off-peak electrical rates.

Zimmerhanzel: Electric motors dominate the selection. Variable speed drives deserve consideration. You can use either a fluid drive or variable frequency equipment. In some applications, gas turbines may prove economical.

Fox: If power is available, we use electric motor prime movers. From a maintenance standpoint, the electric motor is simple to service. But there is a *caveat* here — many small rural electric companies cannot provide enough power to start a 1000-hp motor.

Crawford: If cost can be justified, the gas turbine should be considered. Today's electrical motors are more efficient.

Darwin: We are looking at variable speed electric motors and higher efficiency motors.

Clynch: The variable speed a.c. motor is limited to specific applications to solve specific power problems.

Stout: We have some variable speed electric motors in our system. When we buy new motors, we intend to look at them.

PGJ: *What is the trend in pump station pumps?*

Clynch: Primarily multistage, split case, horizontal centrifugal pumps.

Stout: We are changing impellers to improve efficiency.

Zimmerhanzel: Centrifugal pumps — horizontal split case design — remain the most popular.

Dennard: Centrifugals are now universal. The multistage centrifugal can be operated in many combinations for best efficiency.

Darwin: The horizontal split-case centrifugal seems to be the most widely accepted.

Fox: All of our pumps are centrifugals. They are the most adaptable.

Crawford: Centrifugals are now used everywhere.

PGJ: *What product improvements have contributed most to your decision to modernize?*

Dennard: The variable speed motor has been a real innovation. Microprocessors and the resultant control and data collection systems are important.

Zimmerhanzel: Electronics have made a big contribution toward station automation. We use RTUs when upgrading a station.

Darwin: Application of electronics to many functions has given us better surveillance of pipelines and pump stations and better control of both. Electronics has also aided the need to modernize and support instrumentation.

Crawford: Electronics. The new electronic devices have helped reduce maintenance costs and given us greater flexibility. Improved measurement devices. Cost of products is so high you must have precision measurement and control. Computers make retrofitting possible and the use of computers adds a higher level of sensitivity.

Fox: Computerization of remote controls. Microprocessors, which have many, many applications.

Clynch: Automation for stations. We are installing or replacing remote terminal units with "smart" RTUs. With these, data is processed on-site and minute-to-minute adjustments are made automatically without the central dispatcher being involved.

Stout: Significant technological development has occurred in solid state controls. High speed, smaller meter provers with excellent accuracy have been an important development.

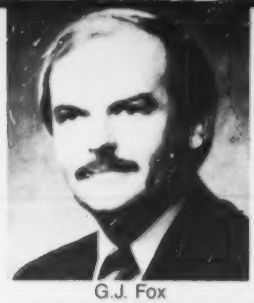
PGJ: *When you modernize a station, do you replace yard piping? Valves and actuators? Local controls?*

Fox: We do not replace yard piping unless it is of the wrong configuration or is bare pipe that needs coating and cathodic protection. Valves are not generally replaced but are retrofitted with motor operators. We regularly change out local controls. Most of them were pneumatic. We now use electro-hydraulic systems.

Stout: We revise yard piping to permit isolating the mainline from the station for safety. We try to keep piping aboveground and, on our product pipelines, we try to eliminate traps that spread interfaces. Valves and valve actuators are updated as necessary.

Zimmerhanzel: We replace yard piping, valves and actuators, and local controls as necessary.

D.L. Dennard



G.J. Fox

G.M. Stout

J.E. Zimmerhanzel

Total Liquids Pipelines — Mainline & Gathering Pump Station Modernization/Replacement Estimates

	1981	1985-87
Number of mainline stations to be modernized	288	475
Number of mainline stations to be replaced	7	12
Number of field gathering stations to be modernized	251	417
Total expenditures for modernization/replacement	$131 million	N/A

Darwin: Changes in yard piping are made on a location-by-location basis. Depends on condition, proper sizing, pressure drops, and complexity. Changes in valves and actuators will also depend upon the situation. We like to replace actuators with newer, more reliable operators. We do not change for the sake of changing.
Clynch: Normally we do not replace yard piping. We check it annually and sometimes we rearrange for better operation. Valves and actuators are updated. We have replaced a lot of station valves.
Crawford: Depending on condition we might replace yard piping. It is not mandatory. Valves and actuators are replaced as needed depending upon the situation. Automation of a station would affect the decision. Upgrading local controls depends on the game plan — we usually do.
Dennard: We look at piping for integrity, function, and the ability to operate remotely. Replacement of valves and actuators depends on age of existing equipment and applications. Only our key stations are manned — stations with complex piping and a lot of metering. Stations are equipped to operate locally when it is desirable to do so. Local controls are upgraded as necessary.

What Liquids Pipeliners Want In New Products/Services...

- Anything that improves efficiency, or reduces fuel or power costs.
- Further developments in variable speed electrical motors — over and above what is available now. Further refinement in control valves and actuators and their applications.
- Better leak detection systems.
- Energy conservation improvements in the equipment used. Safety and environmental control are very important and anything that improves these areas is of real interest.
- A power optimization program that really works.
- Better commercial communications capabilities. The break-up of the Bell system has created problems. It is now difficult to get service, especially on weekends.
- A reliable, positive interface detection system to enable switches to be made accurately at stations as batches change — and to be able to do it remotely.
- Prime movers and pumps with increased efficiency and a better payout.
- Better supervisory control systems.

PGJ: *What type station buildings do you have and what do you build now?*

Darwin: We have all kinds of stations, and the type generally depends upon the age. Oldest stations are of the closed, masonry type. Newer ones are open-air with a canopy.
Clynch: 99% of our stations are open-air design.
Dennard: We have all three types. The area of country where we operate helps determine what type of station we use. While most are open-air, those in the cold country are partially sheltered. Again, when we move a station down the line to achieve hydraulic balance the new station is usually open-air.
Stout: We have all types. We do not remove buildings unless absolutely necessary. All new stations are open-air. We spend quite a bit for noise abatement at our stations, and find that being good neighbors is quite contagious.
Zimmerhanzel: The majority of our stations built recently are of open-air design. Most older stations were built with a shed over the pumping unit. A few were enclosed in buildings.
Fox: There's no rule on station types. Most older ones are of the closed-type design, and we keep them unless there is a good reason to change. For the last 15 to 20 years, we have built partially sheltered stations. More recently we have built open stations with a small building to house controls.
Crawford: We have all kinds; another type depends on the age. All of our new stations are open-air with a canopy.

PGJ: *How does maintenance cost influence modernization and replacement?*

Clynch: Maintenance costs are a primary reason for modernization or replacement. "Too costly" or "no longer functional" are key reasons.
Darwin: Maintenance is certainly a part of the total decision. If older equipment is not supported by the manufacturer and is constantly rebuilt, you have to consider replacement.
Dennard: Maintenance is where one of the biggest potentials for savings that exists today. It is better to replace a station that is too costly to maintain than to keep a costly maintenance program.
Stout: With a system as large as ours, maintenance costs have an impact and it can strongly influence the modernization or replacement decision.
Fox: If maintenance becomes a big cost, the station becomes a candidate for modernization.
Crawford: We keep very detailed records of station maintenance. It is an extremely important consideration. **P&GJ**

NOTE

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AN HBJ ENERGY PUBLICATION

JULY 1984

PIPELINE & GAS JOURNAL®

ENERGY CONSTRUCTION, TRANSPORTATION & DISTRIBUTION

125th Anniversary Issue

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E KIANKA
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Repair Renovate Replace

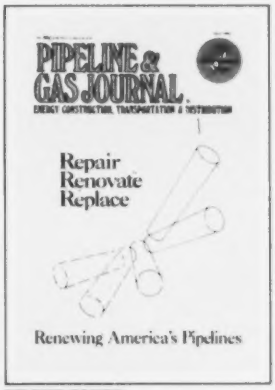
Renewing America's Pipelines

PIPELINE & GAS JOURNAL

Published continuously since 1859 July 1984 • Volume 211 • Number 8

International Pipeline & Gas Utility Design, Construction & Operation

How do you best illustrate, in an abstract manner, the meanings of "repair/renovate/replace"? Presentation Editor James Duke, taking a clue from the CAD (computer aided design) folks, produced this eye-catching design involving a rotating joint of pipe that hints of "aging" via dashed lines.



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New systems/expansions/developments

Repair/renovate/replace is not the same as the 3Rs you learned in school, but it is an educational process that's fast becoming standard in the world of energy pipelines; in this 125th anniversary issue of P&GJ, the editorial staff crunches out some hard fact stats that cannot be ignored, and assesses the situation as it stands today.

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America's energy pipeline system is growing old. Keeping the system strong and secure will require a heavy application of the 3Rs.

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Four of the oldest gas distribution utilities in the U.S. are among the strongest and most up-to-date in terms of outlook for the future.

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New way to make in-place renewal of older cast iron mains is proving cost effective for Elizabethtown (N.J.) Gas Co.

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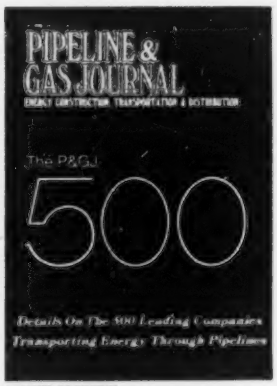
Part II of report tells how test program compared the MicroProver to a full-sized prover at various rates.

49 120-In. Steel Pipe
New water line in Washington uses 120-in. steel pipe coated with PE tape.

Only report of its kind on the U.S. energy pipeline industry, The P&GJ 500 is a unique overview of the structure of the nation's pipeline/gas utility network. An important tool for planners, analysts, management, and engineers, both as a reference and a benchmark, it profiles the top 300 gas distribution utilities, the top 100 gas transmission and gathering pipelines, and the top 100 liquids pipelines.



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Time to Renew

SPECIAL REPORT
by DEAN HALE, Editor

America's energy pipeline system grows older every day. The nation's vast network of oil and gas pipelines and gas distribution utility mains and services has had tremendous growth in the nearly 40 years since the end of World War II. About half of all energy piping now in operation has been installed in the past 25 years.

The other half goes far back in time. It includes many miles of lines built in the 1920s and 1930s, and even some cast iron mains that are more than 100 years old.

This aging is of continuing and vital concern to the pipeline and gas utility industry. As the piping system has reached a point of maturity and demands for new "expansion" facilities have diminished in recent years, companies have found it necessary to channel increasing funds for replacement of older, less efficient lines. Today's budgets for construction reflect that – often more money is dedicated to replacement than new installations.

Of the estimated $9.7 billion that the U.S. energy pipelines will spend in the next 12 months, PIPELINE & GAS JOURNAL estimates that 50% will be used for the 3Rs – repair/renovate/replace.

America's energy pipeline system now totals 2,018,052 miles. That includes 1,346,025 miles of gas mains and services; 394,407 miles of gas transmission and gas gathering pipelines; and 277,620 miles of crude oil trunk, crude oil gathering, and refined products pipelines.

Approximately 44% of the gas mains and services are more than 25 years old; 49% of the gas transmission and gathering lines are more than 25 years old; and 53% of the liquids lines are more than 25 years old.

The aging is not uniform. As shown on accompanying regional data maps and charts, some areas have relatively new gas utility systems and old pipelines, while others have old gas systems and newer pipelines. Some areas, in total, are younger overall than others. The vintaging of the piping systems often reflects the population growth and economic development of the regions over time.

What's wrong with these energy pipelines? Nothing. But, like our human bodies or our homes or our cars and trucks, they require more upkeep as they get older.

That upkeep also costs more. Maintenance and repair is expensive in today's congested world, one that is getting more congested all the time. Sometimes it is cheaper to replace a facility than to repair or renovate it.

Maintenance is good. Operating companies have consistently maintained their pipeline and utility systems. Their standards are tough. They have a strong obligation to protect the public. They also have enormous investments to protect. They must deliver energy efficiently. That demands that the system be kept in first class condition.

Thus, an increasing larger share of budgets goes for maintenance, repair, and replacement.

Gas distribution utility companies, for example, follow up and quickly fix reported leaks. These companies firmly believe that safety is a prime objective and they operate that way.

Liquids and gas pipeline companies, even where they have pipeline systems strung out over miles and miles of remote areas, constantly check and patrol their pipelines and use sophisticated equipment to detect even the smallest glitch in the operating system.

Pipeline safety legislation enacted by the Congress in 1968 has established minimum performance standards and helped the small, marginal operator improve operating practices.

Data accumulated by the Department of Transportation in the 15 years since the pipeline safety legislation was enacted indicates that the industry has an outstanding record.

Pipelines are safest. Pipelines are the safest of all transportation modes. Pipelines transport roughly 60% of the nation's energy supply.

In 1982, according to DOT, there were 1,711 gas pipeline "failures" and 200 liquids pipeline "failures" reported. Remember – that's for more than 1.74 million miles of gas lines and 277,000 miles of liquids lines. That's only one failure per 1,017 miles of gas line and one failure per 1,385 miles of liquids lines.

Even more important – more than 60% of those failures was caused by "damage by outside forces." Being around energy pipelines is a lot safer than riding in your family automobile or taking a bath in your home.

(A "failure" is a leak, no matter how small, that is repaired, and includes "damage by outside forces," generally when third party contractors – such as sewer and water contractors or highway builders or maintainers – damage buried lines because of negligence.)

Repair/renovate/replace. There is no escaping from the 3Rs if pipeline systems are to be maintained in first class condition. Repair of systems is frequently on a priority basis. Leaks, when found, must be repaired immediately. Conditions that *could* become hazardous are next on the priority list.

Renovation and replacement take more time to plan and execute. Each must be accomplished with skill and a knowledge that the procedure and materials involved are adequate and proper for the job. Each is expected to produce long-term results.

Renovation generally involves upgrading of an existing facility, such as internally coating joints of an older cast iron main or internally cleaning and coating – in-place – an existing steel pipeline.

Replacement is a final step. It may involve a procedure such as renewal by insertion of a plastic pipe inside an older, in-place steel or cast iron main, or installation in another location of a completely new pipeline or gas main that will result in the abandoment and non-use of an existing line.

ENERGY PIPELINE MILEAGE IN THE U.S.

AREA	Gas Mains	Gas Services	Gas Trans. Pipelines	Gas Gath. Pipelines	Crude Pipelines	Crude Gath. Lines	Product Pipelines
Northeastern	147,397	116,991	27,903	16,035	2,683	6,692	8,453
Southeastern	148,000	43,858	39,888	4,283	2,583	2,541	8,695
North Central	239,935	148,951	82,447	13,750	21,547	16,958	38,759
South Central	149,605	59,378	119,675	45,252	44,315	59,173	30,204
Northwestern	48,664	23,510	19,364	10,234	7,444	4,996	6,140
Southwestern	88,552	82,579	14,629	947	6,541	4,808	5,088
TOTALS	870,758	475,267	303,906	90,501	85,113	95,168	97,339

Repair
Renovate
Replace

What will be required? Obviously, wholesale replacement or renovation of older facilities – just because they have grown older – is neither required or desirable. No one is really certain just how long any particular type of installation *can* last. There are, though, guidelines that provide age ranges when facilities are no longer economic to operate or maintain, and these point the way toward renovation or, ultimately, replacement.

If only 1% of our total pipeline energy system were replaced each year, it would involve 20,100 miles of replacement pipe. To keep the total system at 50 years of age or younger, about 2% – or 40,200 miles – would have to be replaced each year. Currently, only about 12,000 to 13,000 miles are being replaced.

That's not enough. The industry's challenge will be to double or triple the annual replacement mileage.

"Infrastructure renewal" programs by municipalities and other government agencies will create many new problems for gas utilities and for oil and gas pipelines in the next couple of decades. As water and sewer utilities are renewed, along with streets, bridges, and highways, the demands for utility line relocation will be enormous. Such relocations are in addition to normal 3R programs and, conceivably, could eat away at available budgets. *(A comprehensive seminar-report on this subject appears in the PIPELINE & GAS JOURNAL November 1983 issue, page 18.*

Energy system renewal extends beyond piping. Pump and compressor stations have much shorter life spans and must be renewed sooner. So do control and communication systems, meters and measurement facilities, storage tanks, peakshaving plants, and a great variety of other facilities. Nothing escapes the 3Rs.

Time to renew. Without adequately planned programs, the U.S. energy, pipeline industry will have systems that are ailing from leaks, inadequate capacity, inability to handle today's operating pressures, and just generally poor physical condition.

Without exception, the gas distribution utilities and the oil and gas pipeline companies contacted by PIPELINE & GAS JOURNAL in preparation of this report said they are very aware of the aging of their systems and are planning for renewals and replacements to resolve future problems.

These companies are the leaders in their respective areas of the pipeline energy business and comprise the PGJ 500 list of 300 top gas distribution utilities, 100 top gas pipelines, and 100 top liquids pipelines.

In the total energy pipeline industry, there are an estimated 1,650 gas utilities, 300 gas pipelines, and 500 liquids pipelines.

It is in the other 1,950 companies where some problems may exist.

Federal safety regulation. How good is the federal safety regulation program? Is it adequate? Is it properly addressed? What needs improving?

A recent General Accounting Office re-

GAS DISTRIBUTION SYSTEM DATA

What Causes Leaks:	
Corrosion	40%
Construction or material defect	20%
Other	40%
Where Leaks Occur:	
Mains	43%
Services	42%
Other	15%
Locations Of Leaks:	
Pipe	60%
Valves	3%
Fittings	13%
Drips	1%
Regulators	3%
Taps or tap connections	3%
Other	18%
Leaks – By Age:	
1970-Date	13%
1960-1969	10%
1950-1959	16%
1940-1949	11%
Before 1940	50%

Materials Of Construction:	Mains	Services
Steel	76%	74%
Cast Iron	8%	negl.
Copper	negl.	3%
Plastic	16%	23%

Mains By Size:	
1-in. or less	5%
1 to 2-in.	49%
2 to 4-in.	28%
4 to 6-in.	11%
8-in.	4%
10-in.	1%
12-in.	1%
Over 12-in.	1%

Mains And Services By Date Of Installation	Mains	Services
1970-1983	28.8%	32.6%
1960-1969	27.7%	22.8%
1950-1959	16.5%	17.3%
1940-1949	5.2%	6.4%
Before 1940	21.8%	20.9%

GAS TRANSMISSION AND GATHERING SYSTEM DATA

What Causes Leaks:	
Damage by outside forces	41%
Construction or material defect	38%
Corrosion	15%
Other	6%
Where Leaks Occur:	
Transmission lines	97%
Gathering lines	2%
Other	1%
Locations Of Leaks:	
Body of pipe	49%
Girth weld	6%
Longitudinal weld	20%
Compressor	1%
Valves	2%
Tap connection	4%
Fittings	8%
Other	10%

Materials Of Construction:	Transmission Lines	Gathering Lines
Steel	99%	96%
Plastic	1%	3%
Other	—	1%

By Age: When Installed	Transmission Lines	Gathering Lines
1970-1983	20.4%	24.0%
1960-1969	28.6%	12.1%
1950-1959	27.3%	27.6%
1940-1949	10.0%	9.7%
Before 1940	13.7%	26.6%

Transmission, Gathering Lines By Pipe Size:			
1-in. or less	negl.	26-in.	6%
1 to 2-in.	4%	30-in.	12%
2 to 4-in.	11%	34-in.	1%
4 to 6-in.	10%	36-in.	4%
8-in.	10%	40, 42, over 42-in.	1%
10-in.	6%		
12-in.	9%		
14-in.	1%		
16-in.	7%		
18-in.	2%		
20-in.	7%		
22-in.	2%		
24-in.	8%		

Repair
Renovate
Replace

port to Congress on federal-state pipeline safety programs recommended that DOT be given more funds for more inspectors to meet its goal of comprehensive annual inspection of all pipeline operators. GAO has also recommended that interstate pipelines maintain quality assurance programs. It is apparent, in reading GAO's recommendations, that GAO is not knowledgeable about how major interstate pipeline companies operate. They already have their own quality assurance programs. Intelligent, efficient, profitable operation requires such programs.

The problem is not with the larger and efficient operators.

Where the federal-state pipeline safety program breaks down is in comprehensive jurisdiction over – and inspection of – small municipal gas utilities and small pipeline operations (generally intrastate) that are not monitored or are just barely recognized.

There is also a problem of the "master meter" installations (estimated at 27,400) under DOT jurisdiction. These "operators" are neither fish nor fowl. They certainly are not gas utilities. But they do represent problems in safe operation. At present they get little if any inspection or attention.

Of the 39 states with liquids pipelines, GAO found, 17 states are not interested in assuming any jurisdiction over the pipelines. Of the remaining 22 states, 14 have the necessary state legislation to regulate safe operation, and 8 have requested it.

Renewal, Resolve, Regulation. Renewal certainly has become a major concern of the bulk of the companies who operate the nation's pipeline energy system.

The increasing amount of capital expenditures budgeted for repair/renovate/replace programs is indicative of the resolve these organizations have to keep their systems in the highest operating order.

Expanded federal regulation in this area could only serve to impede progress in renewing the pipeline energy system. If federal regulation is to be an effective force in making renewal viable, its efforts must be directed to those areas where no jurisdiction and very little desire for improvement now exists.

The best solution will come when the "average age" of the energy pipeline system no longer becomes a bigger number each year and, instead, begins to move downward.

Gas Industry Full Partner In America's Energy Future

by O. C. DAVIS,
Chairman, American Gas Association, and Chairman, MidCon Corporation.

It's an exciting time to be a pipeliner. Exciting because natural gas, thought by many a few years ago to be a fuel of the past, is now being recognized as an energy resource with an established importance to America's future.

Today, natural gas pipeline systems across America are moving beyond traditional repair and maintenance activities into renovation and expansion of existing lines and the construction of new gathering and transport systems. This effort will maintain the priceless national asset represented by our current million-mile pipeline system.

In fact, America's abundant supply today and the supply outlook throughout North America holds tremendous potential for the natural gas industry.

The natural gas industry is now undergoing a transition marked by increasing supply, moderating price, and growing demand. It is a transition that has demonstrated to producers, pipelines and distributors the critical importance of working together to assure that natural gas plays the major role it should in the nation's energy future.

Progress in our industry over the last three decades has been impressive. For example, in the early 1950s, only one transmission company had as much as 7,500 miles of in-service transmission pipeline. Today, a dozen companies exceed that operating mileage, and earnings in these companies have increased comparably. The link between the growth of the pipeline industry and the service it provides to the public is not coincidental. Through research and experience vast improvements have resulted in construction and operations. Equipment and pipeline materials have been greatly improved. All of this resulted in a record for safety and reliability that likely is not equaled in American industry.

Pipeline load capacities have been expanded to provide a transport capability of 23 Tcf versus the 5 Tcf transported in the early 1950s.

Compression energy for pumping of natural gas has more than tripled in this period to more than 17 million horsepower. Underground storage capability, which is vital to economic and efficient operation of the nation's natural gas pipeline system, has expanded to more than 6 Tcf, or better than 25% of the annual sendout.

Natural gas pipeline companies have significantly enhanced the economic progress of our nation. This is evidenced by an increase of gas utility customers over these last 30 years from 26 million to more than 46 million customers.

All of this has been accomplished by pipeline companies meeting their responsibilities to consumers through voluntary agreements negotiated among pipelines, suppliers and their customers, subject to regulatory approval. The current flirtation with mandatory carriage, if written into law, would restructure the gas industry and create pricing problems for consumers while adding another unnecessary layer of federal regulation.

As we approach the mid-point of the decade, the natural gas industry is as vibrant as it was 30 years ago. New technological advances continue to be made; traditional domestic supply potential appears to be adequate well beyond the end of this century; prices are stabilizing well within competitive limits; and marketing opportunities nationwide are improving. The well-being of our industry over these broad fronts is important to the economic and social health of our country.

For the near future, the natural gas industry predicts that capital requirements of the industry from now to the year 2000 will approach $300 billion. Of this amount, more than a third will be dedicated for pipeline and utility construction and maintenance. As such, the nation's natural gas pipelines are committed to the task of assuring that gas energy continues to be a full partner in America's energy future.

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Research Key To Safe, Efficient Energy Pipeline Operation

by **GEORGE H. LAWRENCE,**
President, American Gas Association

The nation's natural gas distribution and transmission companies are engaged in ambitious programs to assure the continued efficient and safe operation of America's million-mile gas energy pipeline system.

The American Gas Association addresses pipeline research through its Pipeline Research Committee activities, which are independently funded, and through the Association's Operating Section programs.

A.G.A.'s Pipeline Research Committee plays a key role in its developmental and applied research programs aimed at optimizing all technological aspects of the natural gas transmission industry. For more than 30 years the committee has sponsored a variety of important research projects. In 1984 more than $3.5 million is being spent on pipeline research programs. The committee is recognized internationally for the results and conclusions derived from its research.

Research projects currently being funded by the Pipeline Research Committee include stress corrosion cracking, physical process and metallurgy, and full-scale testing. Other important research areas include environmental aspects and safety considerations for field operating personnel. Offshore and arctic research areas will require added expenditures as deeper water depths are explored for gas production. Studies are now in process to evaluate pipeline integrity, vertical pipelay, and stability for on-bottom flow conditions for water depths surpassing 3,000 ft.

Two recently completed pipeline research projects covered the ultrasonic detection of girth weld defects in shielded metal arc welds and the evaluation of acoustics as a test medium to determine whether source and signature of the signal could identify and classify pipeline anomalies.

The Pipeline Research Committee also has improved operations of underground storage reservoirs, two-phase flow and the long-range implementation of possibly using pipelines for the commercial transmission of hydrogen.

The Operating Section of A.G.A., which is concerned with engineering and technological aspects of the gas industry, provides a unique forum for formulating an industry consensus to respond to proposed state and federal initiatives affecting gas operations. In addition to interfacing with many scientific, trade and government organizations, the Section sponsors an annual Transmission/Distribution Conference where approximately 1,200 participants take part in the dissemination of information on technological advances for all facets of gas company operations.

A major project involving most of the Section's committees is the development of the Gas Engineering and Operating Practices series, a five-volume publication covering the broad spectrum for technical aspects of gas supply through the end use of gas.

Natural gas pipelines deliver directly from the wellhead the most efficient, cleanest and most economic fuel to the nation's 160 million gas users.

Today, the U.S. has an abundant supply of domestic natural gas that can be delivered to these consumers and used to strengthen the nation's economy while reducing America's dependency on foreign oil.

Natural gas in the U.S. and around the world is well positioned to make a growing long-term contribution to the energy mix.

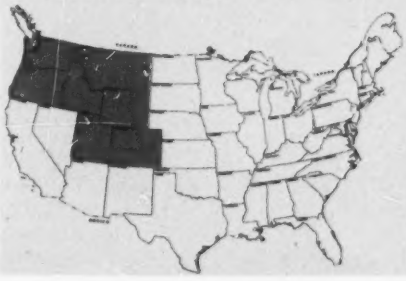
The gas industry is committed to maintaining, rebuilding and renewing the priceless national asset that America's unique pipeline delivery system represents in order to best serve current and future gas consumers.

SOUTHWESTERN AREA

	Gas Mains	Gas Services	Gas Trans. Pipelines	Gas Gath. Pipelines
1970-1983	23.3%	27.0%	10.0%	16.8%
1950-1969	49.4%	50.7%	65.0%	52.0%
Before 1950	27.3%	22.3%	25.0%	31.2%

SOUTHEASTERN AREA

	Gas Mains	Gas Services	Gas Trans. Pipelines	Gas Gath. Pipelines
1970-1983	21.8%	27.1%	11.6%	31.7%
1950-1969	56.7%	50.7%	72.9%	16.2%
Before 1950	21.5%	22.2%	15.5%	52.1%



NORTHWESTERN AREA

	Gas Mains	Gas Services	Gas Trans. Pipelines	Gas Gath. Pipelines
1970-1983	28.3%	33.4%	23.7%	52.0%
1950-1969	56.8%	54.8%	65.6%	42.5%
Before 1950	14.9%	11.8%	10.7%	5.5%

NORTH CENTRAL AREA

	Gas Mains	Gas Services	Gas Trans. Pipelines	Gas Gath. Pipelines
1970-1983	20.8%	25.5%	9.7%	36.3%
1950-1969	46.4%	46.9%	63.1%	46.4%
Before 1950	32.8%	27.6%	27.2%	17.3%

Nation's Gas System Is In Overall Excellent Condition

by TAYLOR G. HOLLAND
President, Mississippi Valley Gas Company, and Chairman, Southern Gas Association

Two facts must be kept in mind in any discussions of pipeline safety: one, the gas industry is its own most vigilant watchdog, and two, the number one cause of pipeline damage is careless digging by third parties, not deterioration. In the most recent report by the Department of Transportation, 61% of pipeline accidents were caused by damage from outside force.

It is, of course, in the industry's best interest to monitor the soundness of its systems. At today's prices, "unaccounted for" gas can be a major expense. The economic benefit to consumers of careful pipeline maintenance is at least matched by the economic benefit to the industry. Proper and prolonged functioning of pipeline systems – their compressors, regulators and meters – all demand an ultra-clean product; and the product demands an ultra-secure transmission system for most efficient distribution.

It is standard operating procedure at Mississippi Valley Gas to inspect and record the condition of pipe anytime a section is uncovered. And, throughout the industry, when exposed lines are examined inside and out, the most common observation by far is that the pipe is in excellent condition.

A number of factors contribute to the overall excellent condition of the nation's gas distribution system today. First of all, the normal life of a gas field is far less than the life of the gathering lines. Then, too, a substantial part of the transmission systems in operation today were built in the 16 years since passage of the Pipeline Safety Act, and do meet the high standards required under that act.

SOUTH CENTRAL AREA

	Gas Mains	Gas Services	Gas Trans. Pipelines	Gas Gath. Pipelines
1970-1983	24.9%	23.6%	16.5%	47.2%
1950-1969	43.8%	38.0%	58.9%	29.2%
Before 1950	31.3%	38.4%	24.6%	23.6%

And, finally, advancement in technology has been a major factor in effective pipeline maintenance.

Mississippi Valley Gas was a pioneer in the development of cathodic protection, now an engineering standard nationwide. Modern construction methods and techniques, and new, superior materials also have helped in building more secure systems.

Contrary to a common assertion, increasing commercial and residential development around existing transmission systems actually increases the safety factor. Relocations, expansions in capacity and other changes required by such build-up enhance safety. In addition, the margins between actual operating pressures and design ratings of the pipe also must be increased.

What, then, are the conclusions? The same ones we've all been working with for years: technically and actually the nation's gas pipeline transportation system is generally in excellent condition; the largest problem is still damage by third parties, not deterioration. Major emphasis by government regulations – and the industry – should be preventive information. "Call Before You Dig" should be required.

In Mississippi, as in some other areas, there now is a one-number "Call Before You Dig" center that will help prevent third-party damage to all underground utility lines.

The nation's gas system – gathering lines, long-distance pipelines and local distribution systems – still comprise the safest of all energy transportation methods.

Such preventive measures and requirements as "Call Before You Dig" will make gas lines even safer.

Proven Techniques Ensure Safe Gas Delivery Systems

by ROGER A. YOUNG
President, Bay State Gas Company and Chairman, New England Gas Association

The 32 distribution companies and the pipelines that operate in the six New England states, as individual companies and, cooperatively through The New England Gas Association, are continuously monitoring and upgrading their natural gas delivery systems.

Based on firm, top-management commitment, to provide uninterrupted gas service 24 hours a day, 365 days a year, gas distribution departments utilize proven techniques to ensure safe, underground delivery gas systems.

Corrosion is carefully monitored and controlled through cathodic protection... continuous leak survey work by individual utility crews supplemented by professional technical consultants... the growing use of plastic for many applications that are proving cost effective and safe... the development of new efficient equipment to reduce paving time... improved trenching operations... new cost-effective clamps... much more effective internal sealing processes... these are examples of the ongoing effort by the New England natural gas industry to improve its underground systems at lower cost.

Education is a key element in maintaining system integrity and, through NEGA, personnel in all levels of the operating and distribution departments attend work-

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shops, schools and seminars to improve their technical ability.

The NEGA Pipeline Safety Act Liaison Committee is a national leader as it works closely with DOT to assist in the development of new pipeline safety regulations and to suggest amendments that would improve existing regulations.

Public education is a key part of the New England industry's program. Each year, public safety announcements are delivered to 23 television stations and 230 radio stations to inform the public of proper safety precautions. Recently, more than 2 million "scratch-n'-sniff" bill stuffers were purchased, cooperatively, through NEGA. Prevention of damage to underground facilities by contractors and the public, in general, is of key concern to all segments of the population. Bill stuffers covering the "dig-safe" program were included in every telephone bill in five of the New England states and were included in every electric bill in the sixth.

Individual utility distribution maintenance programs provide a firm basis for the safe operation of underground gas systems. Continuing education, a deep involvement in understanding and developing pertinent local, state and federal regulations and top management's total commitment to safety combine to make today's gas energy network safe.

NORTHEASTERN AREA

	Gas Mains	Gas Services	Gas Trans. Pipelines	Gas Gath. Pipelines
1970-1983	14.8%	19.0%	10.9%	12.9%
1950-1969	43.9%	41.8%	51.3%	16.6%
Before 1950	41.3%	39.2%	37.8%	70.5%

Pipelines Environmentally Desirable, Strategically Secure

by H. T. CHILTON,
Chairman, Association of Oil Pipe Lines, and President and Chief Executive Officer of Colonial Pipeline Company

Liquid petroleum pipelines are almost as old as the first commercial discovery of oil. In 1862, a pilot model pipeline was constructed from a producing well on the Tarr farm near Titusville to a field refinery 1,000 yd away in the Pithole Creek field. After several entrepreneurs failed in efforts to build longer lines, Samuel Van Syckel completed the first commercially successful oil pipeline Oct. 7, 1865. It was a 32,000-ft, 2-in. wrought iron line that was lap-welded with screw-threaded joints and transported 81 bbl of crude per hr from Pithole City, Pa., to the Oil Creek Railroad Station about six miles away.

Today, the U.S. has the largest, most technologically advanced and most cost-efficient crude oil and refined petroleum products pipeline transportation system in the world. This system provides the nation with the safest, most dependable, lowest cost, most environmentally desirable and most strategically secure means by which crude oil and refined petroleum products can be transported.

The U.S. oil pipeline industry operates more than 225,000 miles of crude oil gathering and trunk lines and petroleum products trunk, lateral and delivery lines. More than $21 billion has been expended constructing this vast transportation network that provides the nation with arteries of steel delivering vital petroleum energy.

The system is, without question, cost beneficial to consumers, providing transport of liquid hydrocarbons at exceptionally low price. This is perhaps best demonstrated by the fact that the nation's oil pipelines move about 23% of all U.S. intercity freight, but at a price that constitutes less than 3% of the nation's total intercity freight bill. In 1982, the most recent year for which data are available, this system transported an estimated 570.5 billion ton miles of crude oil and petroleum products, a very far cry indeed from Van Syckel's 81 bbl/hr pipeline.

Oil pipelines have built a solid reputation for safe operation designed to protect the public, employees and the environment. Their safety record is unparalleled.

Oil pipeline companies use many measures to assure continued safe operations. Rights of way are under constant surveillance by aircraft and other means. Public awareness programs are conducted to reduce third-party damage. Cathodic and other protective measures are used to prevent corrosion at critical points, such as road and rail crossings. Line pressures are monitored both by computer and by highly skilled and trained operators and dispatchers ready to take appropriate action should anything by amiss on a system. Constant repair, renovation and replacement programs are conducted to assure continued failsafe operations and the most technologically advanced system available.

This industry, which has grown under light-handed regulation utilizing private capital and which has given the nation this efficient, low-cost, dependable and safe mode of transportation, is not, of course, without its problems.

A major goal of the Association of Oil Pipe Lines, for example, is to avoid costly and burdensome fetters of excessive federal government economic regulation of the nation's 146 interstate oil pipelines.

Unlike gas pipelines or electric transmission systems, oil pipelines are not monopolies. Oil pipelines are not federally certificated or franchised, but rather are free to enter any market with a new pipeline. They are competitive with one another and with other modes of transport. They are also high-risk ventures which must deal with ever-changing markets.

Their efforts for regulatory reform have substantial support from the private sector, from the Administration and from federal government agencies.

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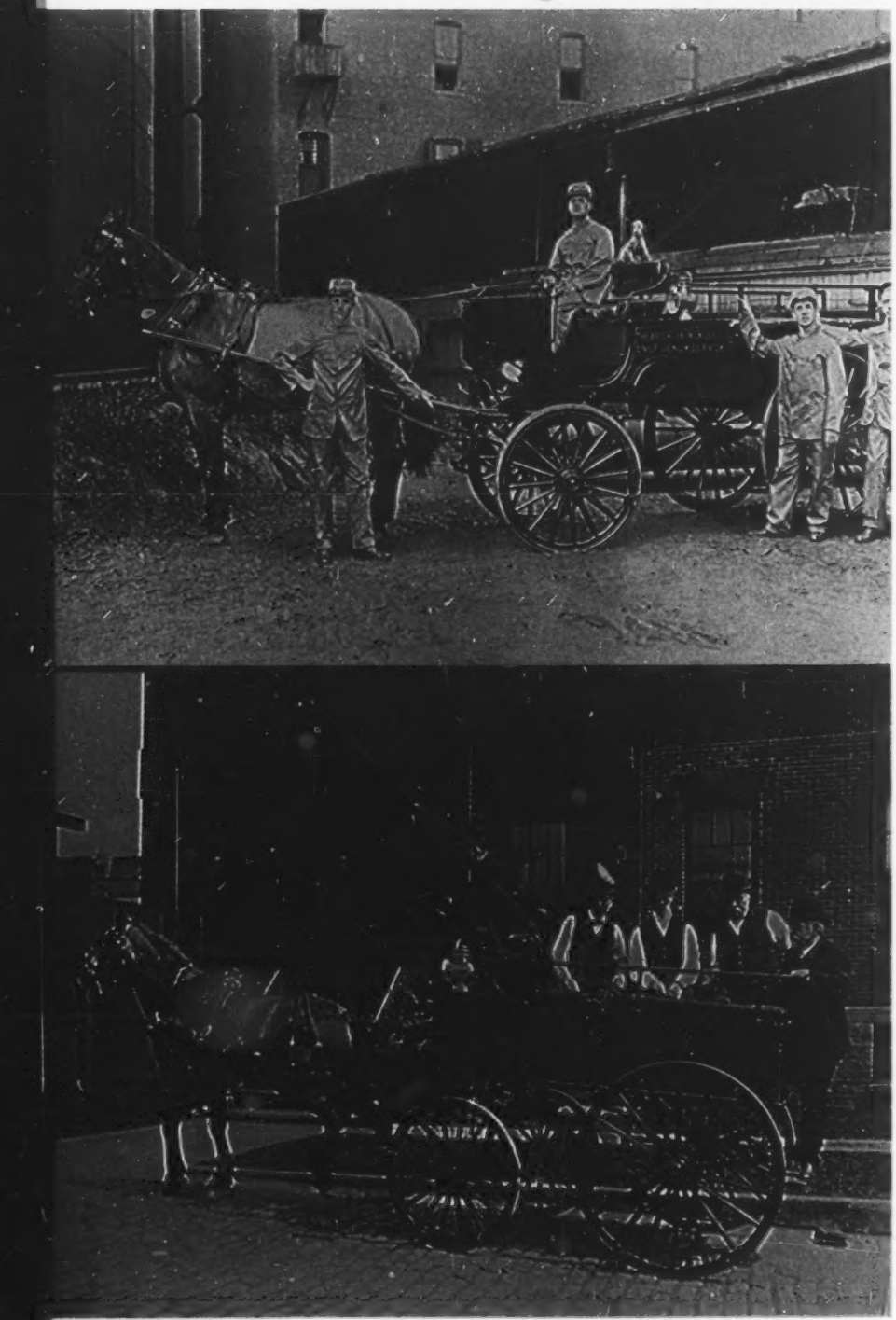
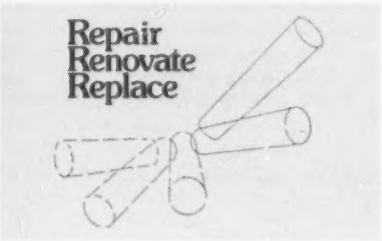
New Ideas, New Techniques Keep Pioneer Utilities Industry Leaders



Even in the early 1900s, Brooklyn Union emergency vehicles carried the latest in modern technology.

by JIM WATTS,
Assistant Editor



One hundred twenty-five years ago, when the first copies of the first issue of this magazine were coming off the press in New York City, Americans in many cities had been enjoying the benefits of gas light for many years. The first gas company in the U.S., and the second in the world, had been chartered in Baltimore, Md., in 1816 and began operations in 1817. Growth in the business was rapid. The July 1, 1859, issue of THE AMERICAN GAS-LIGHT JOURNAL listed 183 U.S. gas companies, from Adrian, Mich., to Zanesville, Ohio.

In those days, gas was made from coal or wood and contained about a third of the heating value of natural gas. Gas was considered useful only for lighting street lamps and home fixtures.

The gas distribution industry has grown over the years to where it can provide reliable, clean-burning energy for any number of applications. It is vigorous, it is vital, and it has made a significant contribution to the standard of living we enjoy today.

But the industry did not go from there to here along a well-marked path. It took people of vision and strong backs to build the nation's energy network. It is going to take even more foresight and hard work and money to keep the system operating in an efficient, modern manner.

To see how it was done and how it is being done, PIPELINE & GAS JOURNAL examines four of the nation's pioneer utilities:

Baltimore Gas & Electric Co.,
Boston Gas Co.,
Brooklyn Union Gas Co.,
and Washington Gas Light Co.

Oldest Utility Stays Modern

BALTIMORE GAS & ELECTRIC CO.

Service Area: The city of Baltimore and all or parts of none surrounding counties, for a total gas service area of approximately 680 sq miles.
Number Of Meters: 513,970
Pipeline Supplier: Columbia Gas Transmission Corp.
1983 Gas Sales: 86 Bcf
1983 Operating Revenues: $545 million
1983 Capital Expenditures: $20 million

For more than 167 years, the citizens of Baltimore have been well served by Baltimore Gas & Electric Co. and its predecessors. The first city in the U.S., and the second in the world, to enjoy the benefits of gas energy continues to benefit from the operations of a modern, vigorous gas distribution system.

Chartered in 1816, the parent company of Baltimore Gas lighted its first street lamp in Baltimore at the intersection of Market and Lemon streets Feb. 7, 1817. For the next 117 years, numerous gas companies competed for customers — there were 11 in the city during the 1880s — and the construction in a street of two or even three mains owned by competing gas companies was not uncommon. The Consolidated Gas & Electric Light Co. of Baltimore was formed in 1933, and from that evolved the modern Baltimore Gas & Electric Co.

Being part of a combined utility — one offering gas as well as electric energy — makes a significant difference, said J. T. Wellener, manager of the gas supply department.

"A combination utility has a different way of looking at things," Wellner said. "Electricity and gas are natural competitors in the home market, but we don't try to compete with electricity for the residential customers. A high industrial load is where we make our money.

"Of course, we have an obligation to give our residential customers the best service that we possibly can, and we will always do that," he said.

Wellener said Baltimore Gas is much more interested in the large industrial customer.

"In our marketplace, the gas company has very limited potential for growth," he said. "If we have a balanced load factor — if we can use our system more efficiently — all our customers will benefit."

Another advantage of a combined utility is more efficient use of personnel. The company's distribution and construction forces were reorganized in 1973 and combined with the electrical division as electric lines were moved underground. Mains and lines sometimes are laid in the same trench.

"We combined all forces for the economy of sending one crew to do two jobs," Wellener said. "We've had quite a bit of success."

Of the company's 4,265 miles of main, 1,200 were installed prior to 1940. Much of the system consists of cast iron or steel mains, with a large number of copper services which are being replaced with plastic lines. Plastic inserts also are being used to rejuvenate some of the older cast iron lines, a process Wellener said is working very well in Baltimore.

Most maintenance and repair work is done by company crews, but construction projects usually are contracted out.

"We find that contractors will do a fine job if we have an adequate inspection effort," Wellener said. "We like 'fixed lid' contracts, because it's easier to watch a contractor in respect to price than it is to keep an eye on productivity."

One of the biggest aids to increasing the company's efficiency has been the use of simulation modeling, Wellener said. Baltimore Gas uses the system developed by Stoner Associates, Carlisle, Pa.

"It's a revolution in networking," Wellener asserted. "In the old days, you might have 12 ideas about how to solve a problem, but it was too expensive and time consuming to examine them all. Now one person can get most of the information in an hour."

A "very good leak survey department" has helped Baltimore Gas keep down its lost-and-unaccounted for gas, Wellener said.

"We have a tremendous record on unaccounted-for gas," he said. "We simply don't tolerate any exposure of our customers to a hazard."

Many older systems are plagued with joint leaks, but Wellener said the unbroken use of oil fogging in older segments has kept the extensive cast iron system in good shape and relatively leak-free. Ethylene glycol fogging now is being substituted, he said, and is "doing a slightly better job" than the oil fog.

Antique Wellsbach lamp stands near restored 1860s valve station at Baltimore Gas' Spring Garden works.

A drastic drop in industrial load experienced in 1982 was virtually overcome through a special program in 1983. A special tariff, establishing delivery service for customer-owned gas allows industrial and large commercial customers to buy gas at the wellhead and have it transported through Columbia Gas Transmission Co.'s pipelines to Baltimore and then to their facility. Twenty of the company's largest industrial customers already have contracted for gas at the wellhead.

In addition to its pipeline supply and gas from underground storage that it buys from its pipeline supplier in the winter, Baltimore Gas has three peakshaving facilities.

The SNG plant at Sollers Point can produce 60 MMcfd of gas from naptha. On-site storage consists of four 150,000-bbl floating roof naptha tanks and two 60,000-gal. propane tanks.

Propane for peakshaving is provided by the Notch Cliff propane air plant and the Crane storage facility at Seneca Park. A 6-in. pipeline delivers the propane to the plant, which also can receive propane by truck. The storage site has capacity for 6.2 million gal. of propane in an underground cavern. The propane air plant can send out 90 MMcfd of gas with a heating value of 1,030-1,400 Btu/cu ft.

During the summer Baltimore Gas liquefies pipeline gas at its Spring Garden facility and stores it in three tanks with a combined capacity of 12 million gal., or approximately 1 Bcf. The LNG facility has a rated sendout of 187 MMcfd.